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ABSTRACT

This description of the Census DIME (dual independent map encoding) file is directed toward school administrators and their staffs rather than to computer analysts. DIME can be used as the central component for a geographically based management information system. It provides the mechanism for the spatial display of data and for the determination of accessibility on either a vehicular or pedestrian network. The system can be extended to include other information available from the Census Bureau that could be used for a variety of socioeconomic studies such as to project student population changes at the block level and to analyze those areas most affected by the local school taxing scheme. (Author/IRT)

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Atlanta, Georgia

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This report was prepared for the Division of School Finance and Organization, the National Institute of Education, Washington, D. C. with support from the National Institute of Education (NIE-P-0331) and the Georgia Institute of Technology (E-20-601).

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Preface

This description of the Census DIME file and interactive programming is directed toward school administrators and their staff. It is not written as a technical manual for the computer analyst. In reading this document, one must imagine that each application can be easily extended from just a few schools to all facilities and students in the district. However the numeric output and maps are larger which is why they could not be included. One must also imagine the ease and convenience of interactive programming. A portable terminal weighing less than thirty pounds that can be connected to any telephone was used for this analysis of pupil assignment alternatives. Considering the importance of sound decision making and the immediate availability of a major portion of the data, the investment required to use the programs described here is small.

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I. Decisions - Analysis of Alternatives

Limited financial resources along with declining or shifting enrollment are creating serious difficulties for many school systems. These difficulties are exacerbated by demands for new academic and vocational programs that are more responsive to individual needs and for additional transportation to satisfy judicial guidelines for racial balance. To continue providing the essential services as well as to initiate these new programs, school administrators must maximize the economic efficiency of all functions. This situation makes it imperitive that school administrators have rapid access to detailed information and the ability to examine many possible courses of action. However, such informational needs can rarely be satisfied using manual procedures.

Numerous attempts have been made to utilize computers in the analysis of such a problem as school bus routing. When using a computer, the problem must be translated into mathematical terms. This analytical description of the problem is called a model. By definition, these models do not contain the subjective features of the problem nor perhaps a number of other facets that are too difficult to write mathematically. As a result, models are incomplete descriptions of the "real" problem; however, they may still prove to be extremely useful in finding satisfactory solutions. Unfortunately, many of the computer applications have not met expectations. Although there are numerous explanations in each case for this failure, two factors that may have contributed either directly or indirectly involve the construction of a very

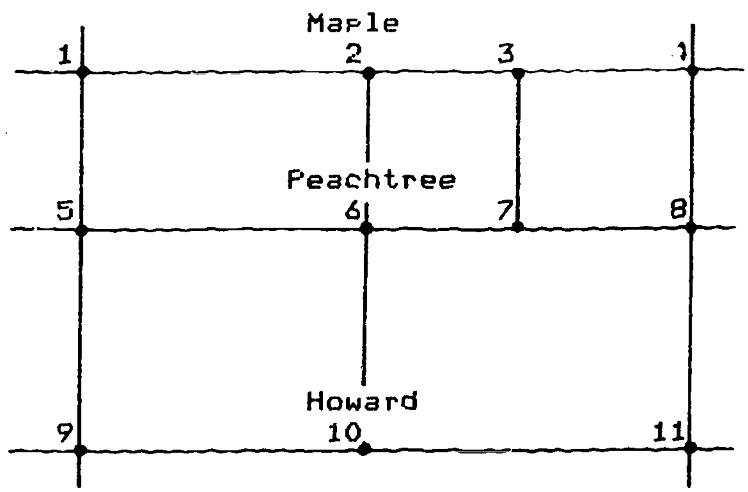
large data base and the delay in obtaining the computer results from the data processing center. These problems can be mitigated by using the Census DIME file and interactive computer processing.

I A. The Census DIME file

The DIME file is a collection of data describing the vehicular transportation network in over 250 standard metropolitan statistical areas. The procedures for constructing and maintaining this data file were developed by the U.S. Census Bureau. "DIME" is an acronym for Dual Independent Map Encoding which refers to the built-in mechanism for checking the internal consistency of the data.

The DIME file is a "segment" structured data base in which each record represents a portion of a street segment as illustrated in Figure 1. The endpoints of each segment, which usually occur at intersections, are called nodes. Each record contains the street name and address range for the segment as well as the coordinates for the two nodes. Two primary uses of the DIME file result from this structure: sequential segment chaining and geo-coded address matching. Segment chaining enables the determination of vehicle or pedestrian routes as well as a method for data validation. For example, the route from node 9 to 3 would include the segments linking nodes 9,5,1,2, and 3. The address matching capability refers to the identification of the record in the DIME file that contains a specified address. Once the record is found, it is possible to associate the coordinate data or a segment location with the

Figure 1: Example of DIME Map and Data File



Street Name	From Node	To Node	Address Range Low	High
Maple	1	2	2	98
Maple	2	3	100	198
Maple	3	4	200	250
Peachtree	5	6	2	70
Peachtree	6	7	102	110

particular address. This information is essential for geographic display of the data or for determining the distance of the data item from another point on the network.

The utilization of the DIME file offers several advantages which relate to the organizational interactions required to construct and maintain this data file. Specifically, the use of the DIME file

a. avoids the duplication of a travel network by government agencies.

b. encourages the transferability of computer tools since many regions will have the necessary data in exactly the same format.

c. relieves school systems of the obligation for developing and maintaining a data base which is already the legislated responsibility of a local or regional planning agency.

d. encourages the coordination of local and regional agencies in maintaining a common data base and transferring information.

e. ensures greater accuracy in the data bases because of multiple agency involvement in its use.

f. provides graphic display capabilities.

g. encourages continual reassessment of pupil assignment and facility management polices since the data base is readily available and up-to-date.

h. makes it unnecessary to construct artificial grid systems to geo-code data.

1. enables the determination of actual distances between any two points on a pedestrian or vehicular network.

In addition, the active support of the Census Bureau further improves the probability of its continued maintenance. For instance, the Census Bureau has invested approximately twelve million dollars toward the development of the DIME file concept and is planning to spend an additional eight million dollars in preparation for the 1980 Census. Furthermore, the new law requiring a census every five years will result in an even greater commitment by the Census Bureau to maintain the accuracy of existing DIME files and expand the program into other areas. Additional information on the Census Bureau's program can be obtained from the Chief of the Geography Division in Washington, D.C.

Other types of transportation or geographic data bases such as traffic zone, rectilinear grid, or land parcel files may also exist for the region. In general, these data bases do not contain the necessary detail nor do they allow for address matching. Thus, the DIME file provides more detail with greater flexibility for information processing and transportation analysis than these other data structures.

Although no data file can contain every factor that must be considered in the implementation of a particular school service, the DIME file does contain sufficient information to enable the meaningful analysis of alternatives. Furthermore, it is an existing data base that is compatible with the present address information on all student records and that can be improved as the situation dictates or when resources are available. Moreover, the immediate

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availability of this data is important in a computer application of this magnitude. The utilization of DIME not only minimizes the short-term cost and time for implementation, but also improves the prospects for the continued use of computer-based decision tools.

I B. Two Interactive Computer Models

Interactive computing allows for a conversational approach to computer usage. At appropriate times, the computer can solicit information from the user, provide the results of initial calculations, and give additional instructions. By responding to a number of simple questions, a person with no special training can use the computer. Consequently, school administrators can work directly with the computer to evaluate the impact of alternative policies. The combination of timely response and the understanding that results from the direct interaction with the computer is likely to yield unexpected benefits.

The nature of interactive computing enables a 'man-machine' approach to problem solving. The models are designed to take maximum advantage of the basic computational capabilities of the computer and to provide output that focuses the user's attention on the critical areas requiring human ingenuity. To provide the timely response necessary for interactive computing, the models must be somewhat limited in scope. However, because of the user's involvement in the solution process, fewer mathematically derived capabilities are required. In this environ-

ment, the computer is used to assist, not replace, the decision maker. However, this does not imply that such models are less useful. On the contrary, it is expected that the immediate access to information and the ability t any alternatives will yield even greater benefit tional mathematical sophistication.

The availability of information should help administrators in anticipating problems and in identifying their causes rather than their symptoms. Often, requests for information remain unfulfilled because of insufficient time or resources. Although a question may not seem critical, the answer may provide the warning signal to the next "crisis." Thus, there is a great potential benefit of timely information that may be difficult to predict. These models can be used to respond readily to the hypothetical questions posed by the facility and transportation planner. For example,

1. If Hope Elementary is closed, what will be the impact on the neighboring schools?
2. If grade levels 1 through 3 are assigned to Forest Elementary and 4 through 6 to Moreland Elementary, what will be the pupil-teacher ratio?
3. What will be the effect of reducing the transportation eligibility distance from 1.5 miles to 1 mile?

Other problems might involve the location of a new school and scheduling the use of existing facilities for community activities such as day care and adult education programs.

Two interactive computer models called PATH and ASSIGN will

be described here. The PATH program determines the shortest distances between home and school for each pupil while the ASSIGN program generates pupil assignments based on these distances as well as facility size. These models will be illustrated using actual data from the DIME file and the Atlanta Public Schools to address several problems related to pupil assignment.

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II. Pupil Transportation Requirements

Fiscal, energy, and racial concerns have focused attention on the transportation service and emphasized the need for tools that can accurately determine tr[illegible]tion requirements. There are many factors that must be [illegible] when determining who is eligible for transportation. For example, the availability of public transit facilities, personal hazard, and the capacity to walk may be taken into account. At this time, however, many states have established policies or laws based solely on a measure of distance between home and school.

The implementation of an established distance measure is neither politically nor technically simple. The political difficulties arise from the uncertainty of a standard procedure for measuring these distances. For example, the distances may be measured along the route that parents would take in transporting their children to school, the route that the school bus would follow, or the way that the child might walk. Furthermore, these distances may be calculated to the driveway, mailbox, or doorstep of the house with measurements made along the curb or down the middle of the street. The technical difficulties are created by the complexity and size of the transportation network.

The traditional approach to implementing a distance criterion involves the use of a measuring wheel and a detailed map or the superimposition on base maps of a circle or square centered at each school. These approaches are extremely labor intensive and usually

do not reflect the exact transportation network, but only indicate a conservative boundary around the area containing those eligibile for transportation. In these approaches, the distance data must then be manually transferred to the student records.

The implementation of a computer program for determining these distances helps to diminish the subjectivity in measurement and to eliminate the time-co[illegible]g t[illegible]nfer of data. Distances are measured on the DIME file network from which streets considered hazardous to pedestrian movement have been removed. Based on a network of four thousand segments, it is possible to determine distances to the homes of several hundred elementary school pupils in only a few seconds. Since the exact distance that a pupil resides from school is added to the student record rather than an indication of whether or not the student is eligible for transportation, it is possible to determine the effects of changing the distance criterion. For example, the consequence of using 1.3 or 1.45 miles as the technical interpretation of a 1.5 mile criterion can be evaluated. It is also possible to determine the impact of transporting all pupils on a particular block when anyone is eligible. Since the model can easily provide a list of names as well as count the pupils eligible for transportation, a more politically appealing interpretaion of the transportation regulation such as the "block rule" is permitted through better enforcement of ridership.

Three computer products are illustrated using data from the DIME file and the PATH program:

1. A chart showing the number of pupils residing at various

distances from their assigned school.

2. A plot of all points in the pedestrian network that are a specified distance from a school.
3. A map of the locations of all pupils that are at least a specified distance from their assigned school.

These applications provide a valuable visual description of a school's enrollment and attendance area.

Table 1 illustrates the [illegible] distance distributions for three elementary schools. The table entries indicate the number of pupils that reside farther than the specified distance "s." These distributions show the degree to which the number of transportables is sensitive to the specified distance criterion. For example, in reviewing the pupil distribution for school S2, there are 168 pupils living at a distance of at least a quarter mile but only 16 residing at a distance of at least a half mile. Furthermore, the number of pupils within a particular distance varies considerably for the other schools. As can be observed, the percentage of pupils living within one mile of their assigned schools ranged from 59 to 76 percent.

Figure 2 illustrates the ring of a transportation eligibility rule. All points on the pedestrian network that are exactly one mile from the particular school are shown. The irregular shape of this ring indicates the complexity of precisely measuring accessibility and the inaccuracy of estimates which are based only on straight line distances. A transparency of the transportation perimeter can then be placed over a street map.

Figure 3 illustrates the location of pupils that are eligible

Table 1: Pupil Distance Distributions

	Schools		
s miles	S1	S2	S3
0.25	122	168	207
0.50	93	16	181
0.75	84	11	139
1.00	33	0	91
1.25	7	0	24
1.50	4	0	4
Total	140	239	211
Percent less than 1 mile	76%	100%	59%

Note: Each entry indicates the total number of students residing farther than the distance 's' from their assigned school.

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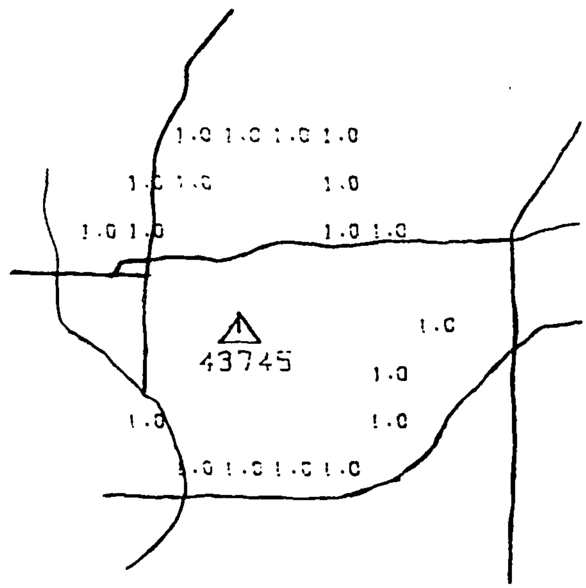
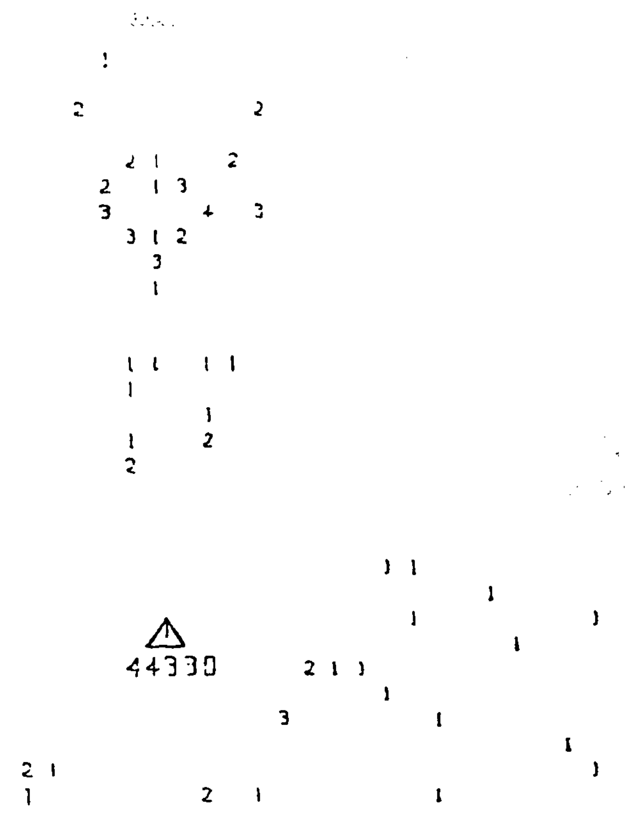
Figure 2: Transport Perimeter



TRANSPORT PERIMETER
WITH MAJOR ROADWAYS ILLUSTRATED

SCALE 1.0 INCHES/MILE

Figure 3: Display of Transportables



TRANSPORTABLES

CRITERION 1.00 MILES .

for transportation, assuming that one mile is specified as the distance criterion determining eligibility. This information is useful in identifying the location and size of pupil clusters for estimating vehicle requirements. The mapping of all pupil locations indicates the number of pupils residing outside the jurisdictional boundaries or inside the attendance area of another school. In addition, a map of students presently assigned to a school that will be closed can be used to indicate visually the potential impact on neighboring schools.

Many school systems already construct similar maps and numeric tables; thus the substance of these applications is not entirely unfamiliar. What may be unusual is that these maps can be produced with minimal expenditure of staff resources and in only seconds of computer time. As a result, it is possible to produce many maps illustrating alternate distance criteria or combinations of school districts with less difficulty and in greater detail than it is generally possible to produce manually a single map.

III. Facility Size and Pupil Assignment

Provision of effective educational opportunities involves consideration of both the accessibility to schools and the proper utilization of academic resources. Continual changes in the characteristics of the student population due to migration, immigration, and academic progress require a frequent reevaluation of the transportation policies and facility planning alternatives. Maximizing the utilization and accessiblity to all schools increases not only the efficient use of the facilities, but also the educational benefits associated with a school of a specified size.

Facility planning and pupil transportation are directly related to pupil assignment. One aspect of facility planning considers the number of facilities and their capacities while pupil transportation considers the distance that pupils reside from their assigned school. Minimizing the distances that pupils walk or ride to school allows more time for classroom activities as well as increases the other benefits derived from the close proximity to a school. Assignment of all pupils to their closest school may be prevented, however, by limitations on school capacities.

Many factors must be considered before stating the desired enrollment since there is flexibility in the number of pupils that could or should be assigned to a particular school. During periods of growth, some schools can temporarily accommodate a larger than normal enrollment until additional facilities are available. When the student population is declining, there may

be a limit on the minimum number of pupils that should be assigned to justify certain educational programs and the operation of the facility itself. Furthermore, it is necessary to maintain the unity of certain student groups. For example, all students living on the same block might be considered as an indivisible group. This will help to prevent the disruption of families and neighborhoods.

School districts are formed by the assignment of pupils or pupil groups to one of the facilities. When pupils are assigned to their closest facility, total pupil transportation is minimized and compact attendance areas are formed. The attributes of compactness and minimal transportation are considered to be favorable characteristics for an assignment plan. However, "closest facility assignment" may produce attendance areas that vary considerably in population density, although not necessarily in spatial area. Having much larger enrollments in some schools may be both educationally and organizationally unacceptable.

When it is undesirable or impossible to assign all pupils to their closest school, a general assignment policy must be adopted. One way of stating this policy is in terms of an objective that is subject to facility capacity limitations. Three alternate assignment rules are presently included in the model:

1. minimize the average travel distance of all pupils,
2. minimize the average distance of all pupils who are eligible for transportation, or
3. minimize the number of pupils eligible for transportation.

The pupil assignments resulting from the implementation of each objective may be very different depending on facility location and size, pupil location, and the specified transportation eligibility distance.

The model assigns pupils simultaneously to all schools so that the selected assignment rule is optimized. The computer program actually completes the task of assigning pupil groups to one of the schools rather than delineating attendance areas. Consequently, this model can be used to generate assignments according to other measures not related to spatial compactness such as student preferences for certain academic or vocational programs. However, it is possible to draw attendance boundaries by encircling the locations of students assigned to each of the schools. In addition to determining and mapping pupil assignment, the program calculates the number of pupils elisilbe for transportation and indicates the number assigned to either their closest or second closest schools.

Figure 4 illustrates an abbreviated output describing the assignment of 1083 pupils to each of four schools. On the map, an "S" indicates a school location while a number indicates the relative location of a pupil group. Figure 5 is a three dimensional projection showing the considerable variation in the density of the student population. In referring back to Figure 4, all students are actually assigned to their closest facilities when considering the approved pedestrian routes although the attendance areas do not appear to be compact. The circle outlines an area that is bisected by a railroad track so

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SCHOOL ATTENDANCE AREAS

SCHOOL       43720- 1
              CAPACITY =      758     AVG DISTANCE =        .27
              ASSIGNED =      190     MAX DISTANCE =       1.15
              UTILIZATION =   .25     TRANSPORTABLE =         0

SCHOOL       43745- 2
              CAPACITY =      894     AVG DISTANCE =        .39
              ASSIGNED =      137     MAX DISTANCE =       2.59
              UTILIZATION =   .15     TRANSPORTABLE =         8

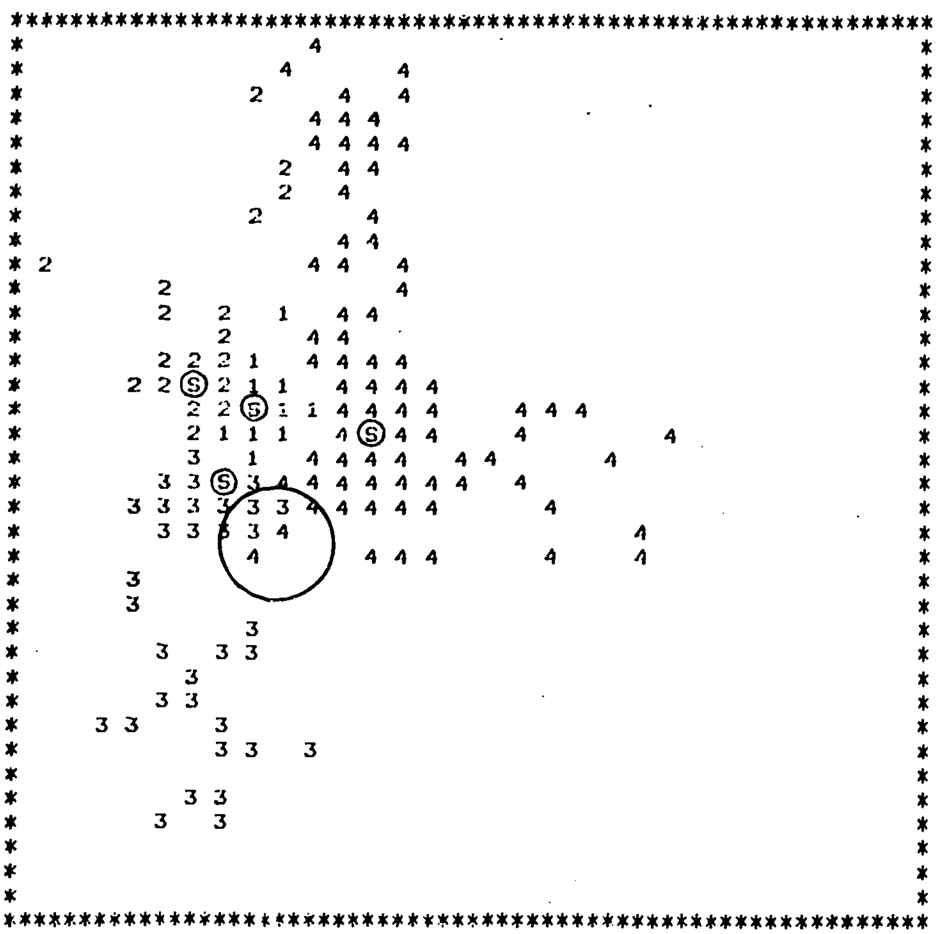
SCHOOL       43750- 3
              CAPACITY =      420     AVG DISTANCE =        .40
              ASSIGNED =      348     MAX DISTANCE =       2.93
              UTILIZATION =   .83     TRANSPORTABLE =        22

SCHOOL       44330- 4
              CAPACITY =      546     AVG DISTANCE =        .73
              ASSIGNED =      408     MAX DISTANCE =       3.43
              UTILIZATION =   .75     TRANSPORTABLE =        51

OVERALL STATISTICS
              CAPACITY =     2618     AVG DISTANCE =        .50
              ASSIGNED =     1083     MAX DISTANCE =       3.43
              MAX UTIL. =     .83     TRANSPORTABLE =        81

              ASSIGNMENT OF PUPILS
              CLOSEST   1083   SECOND CLOSEST      0

              PUPILS LESS THAN
                  .50  1.00  1.50  2.00  2.50  3.00 MILES
                  780   194    32    32    22    23
```



SCALE 1.11 MILES/INCH

Figure 5: Abbreviated Output of the ASSIGN Model

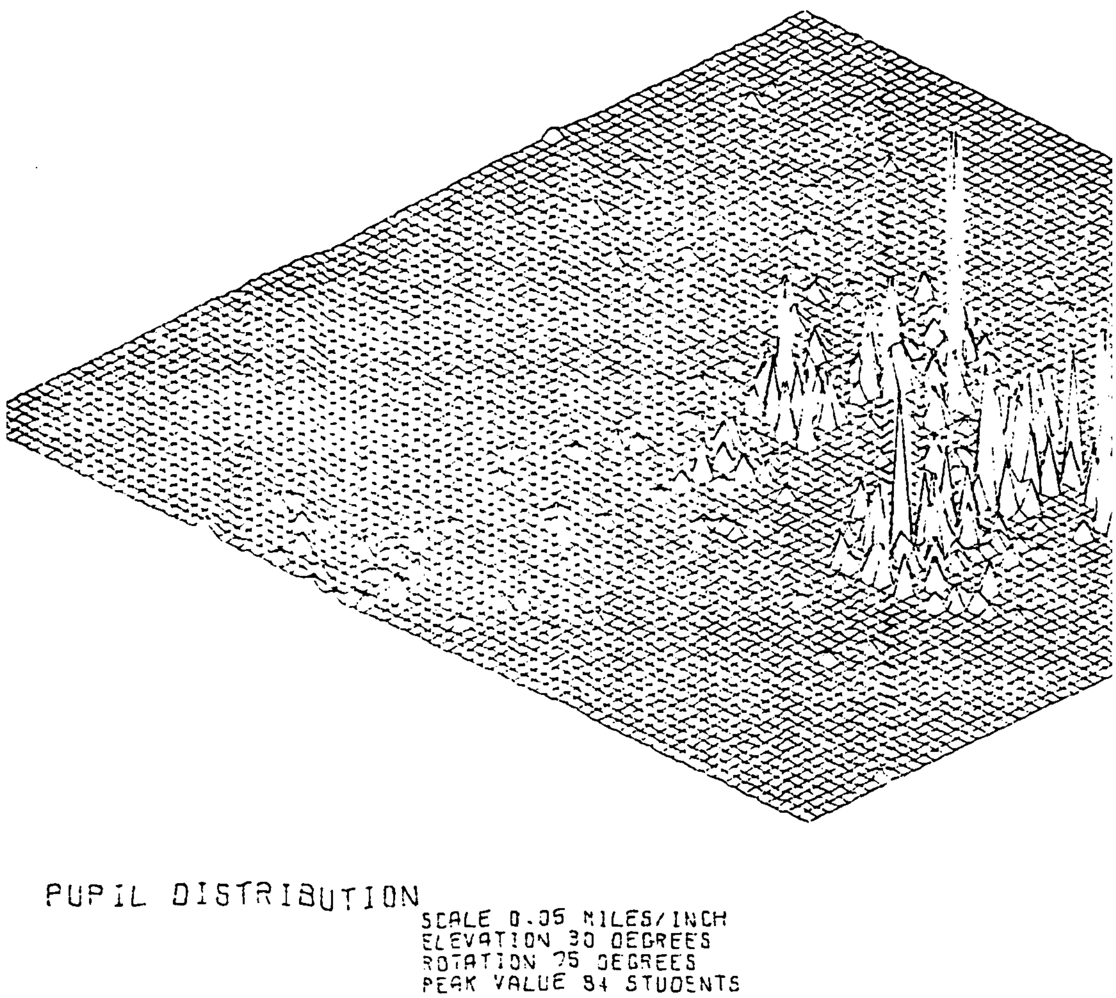


Figure 6: Contour Map of Pupil Locations

that the straight line distance is a poor measure of accessibility. The sophistication of this modeling effort is critical in such circumstances. This type of output can be displayed on any computer terminal. In addition, a complete listing of pupils and their assigned schools can be obtained.

Table 2 shows the summary descriptors for the assignments associated with each assignment rule and three transportation eligiblity criteria. The first row describes the characteristics of an assignment when all four facilities are unlimited in size. In comparison to the other assignments, this solution is superior with regard to both the distance and 'closest facility' measures but may be unsatisfactory because of the wide range in the size of the school enrollments. Nevertheless, this solution does provide a 'base line' for judging the other assignment plans. As illustrated in Figure 6, a single objective does not produce assignments that dominate the other solutions in every respect.

1. Objective 1 is likely to yield superior (minimum) average and maximum distance measures, and therefore, more compact attendance areas.
2. Objective 2 is likely to have more pupils assigned to either their closest or second closest schools.
3. Objective 3 will yield the smallest number of transportables.

In specific situations, an assignment may violate these guidelines because of the requirement to preserve the unity of the pupil groups.

The ASSIGN model considers only facility capacities and pupil

Table 2: Transportation and Pupil Assignment

A. Transportability Criterion Equals 0.75 Miles

School Capacities	Assignment Objective	Distance Avg	Distance Max	Assignment C	Assignment S	T
1083	1	0.50	3.43	1083	0	166
270	1	0.57	3.57	810	183	232
270	2	0.59	4.12	770	262	167
270	3	0.58	4.19	819	192	166

B. Transportability Criterion Equals 1.0 Miles

School Capacities	Assignment Objective	Distance Avg	Distance Max	Assignment C	Assignment S	T
1083	1	0.50	3.43	1083	0	109
270	1	0.57	3.57	810	183	151
270	2	0.58	4.12	793	214	109
270	3	0.58	4.19	806	183	109

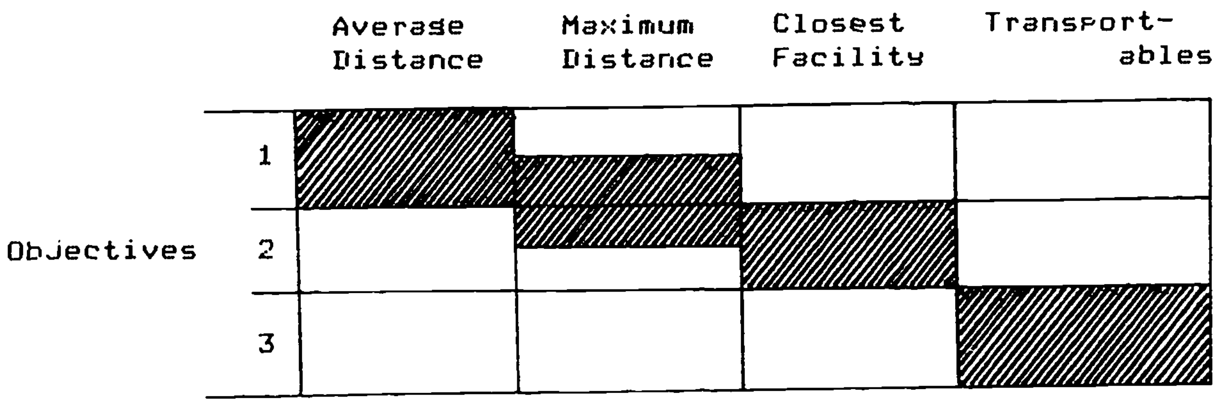
C. Transportability Criterion Equals 1.45 Miles

School Capacities	Assignment Objective	Distance Avg	Distance Max	Assignment C	Assignment S	T
1083	1	0.50	3.43	1083	0	109
270	1	0.57	3.57	810	183	87
270	2	0.60	3.43	803	172	81
270	3	0.56	3.57	831	186	81

Key:

Objective 1 - Minimize average distance
Objective 2 - Minimize average distance of transportables
Objective 3 - Minimize transportables

Figure 6: Comparison of Alternative Objectives



Key:

Objective 1: Minimize average distance
Objective 2: Minimize average distance of transportables
Objective 3: Minimize the transportables

distances. However, there is considerable flexibility in using the model to evaluate a variety of policy alternatives that can be taken into account through data pre-processing. For example, existing computer programs can be used to construct temporary data files for pupils in grades 1 through 6 and 7 through 9. The ASSIGN model can then be applied to these separate portions of the original data base very efficiently. As another example, the partitioning of the DIME file can be used to prohibit assignments that might require pupils to cross railroad tracks, bridges, or busy highways. This is accomplished without the addition of data and its related maintenance problems. Partitioning the data base so that only the essential information is used in the model not only improves the computational efficiency of the program but also prevents certain types of errors from affecting the solution.

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IV. Schools and Declining Enrollment

School size affects the academic and social environment, the extent of pupil transportation, and the cost of maintenance and operation. The capability of a facility to continue serving a particular population may be important because schools are often monuments to civic and national leaders. Furthermore, it can be very costly to close a facility for one or two years and then reopen it. Selecting stable facility locations is complicated by the dynamics of neighborhood evolution and regional mobility.

To illustrate the complementary nature of decisions regarding facility location and size, a situation that has resulted from declining enrollment is investigated. Four schools with a total capacity of 2618 pupils have an enrollment of only 1083. The utilization of these schools ranges from 15 to 83 percent of capacity. Considering only the present student population, it is possible to close any of the four schools and still have sufficient capacity.

In order to evaluate the potential impact of closing a school, a number of facility configurations is investigated. Locations were selected which minimized pupil transportation while balancing school enrollment. Four configurations are identified, representing two to five facilities. Then, for each one of these configurations, a school is removed from consideration. After adjusting school sizes to reflect the smaller number of facilities, new pupil assignments are

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determined. This elimination process is followed for each school in a particular configuration.

The impact of closing a school should reflect the effect on all the descriptors of an assignment plan. The following equation is used to summarize the change in these descriptors:

$$I = [C + S - 100(M+A) - T]/5$$

where I = impact of a school closing,

C = number of pupils assigned to their closest facility,

S = number of pupils assigned to their second closest facility,

M = maximum distance,

A = average distance, and

T = number of transportables.

Increases in the values of the "closest facility" measures C and S indicate an improvement while larger values of the remaining parameters lead to a worsening of the situation. Table 3 contains the results of these calculations for each configuration. To reflect the uncertainty of which facility may be closed, the effects of closing all of the schools in a particular configuration are averaged.

This experiment indicates the variability of the impact of closing a school. With regard to the configuration of four schools, the impact of a school closing actually resulted in an improvement because more pupils were assigned to either their closest or second closest school. At first, it may seem

Table 3: Impact of Facility Closing

A. Five-Facility Configuration Reduced to Four Facilities

School Removed	Range in Assignment	Distance Avg	Distance Max	Assignment C	Assignment S	T	Impact
1	248-252	0.64	2.76	825	133	58	-5.8
2	250-254	0.65	2.76	822	104	56	-12.0
3	250-254	0.67	3.55	849	125	79	-23.2
4	247-257	0.60	3.47	888	116	71	-12.6
5	245-261	0.68	3.20	738	172	65	-26.4
0	159-218	0.51	2.76	949	23	56	

Average impact = -16

B. Four-Facility Configuration reduced to Three Facilities

School Removed	Range in Assignment	Distance Avg	Distance Max	Assignment C	Assignment S	T	Impact
1	357-365	0.69	3.19	869	192	73	8.2
2	359-363	0.77	3.19	927	146	74	8.8
3	360-362	0.76	3.76	934	133	100	-8.8
4	361-361	0.70	3.71	851	223	87	-2.6
0	214-272	0.62	3.19	821	191	72	

Average impact = +1.4

C. Three-Facility Configuration Reduce to Two Facilities

School Removed	Range in Assignment	Distance Avg	Distance Max	Assignment C	Assignment S	T	Impact
1	502-506	0.90	3.88	915	93	99	-19.4
2	501-507	0.79	3.57	938	70	82	-7.6
3	501-507	0.98	4.25	924	84	247	-58.0
0	287-362	0.64	3.40	988	20	76	

Average impact = -28.3

Key:

C = number of pupils assigned to their closest school
S = number of pupils assigned to their second closest school
T = number of transportables

impossible that there can ever be an improvement in the assignment measures as a result of closing a school. This situation can arise when a school is seriously misplaced with respect to the present student population. While positive impact values may not occur often, it is important to note that closing certain schools in each of the configurations has a far less severe effect than closing other facilities. For example, when the three-facility configuration is reduced, the impact ranged from -7.6 to a low -58.0. This limited evidence also suggests that the possible impact of closing a school may be greatest when the total number of facilities is smallest.

While these observations may be obvious, confirmation is achieved at minimal cost. Furthermore, these measures provide quantitative descriptions of the relative impact of each alternative that can be used along with other subjective considerations.

V. Summary

DIME can be used as the central component for a geographically based management information system. It provides the mechanism for the spatial display of data and for determining accessibility on either a vehicular or pedestrian network. In addition, this system can be extended to include other information available from the Census Bureau which could be used for a variety of socio-economic studies such as to project student population changes at the block level and to analyze those areas most affected by the local school taxing scheme.

The quality of decisions is often based on the availability of information. There is a critical need for timely, accurate data by all school administrators and support personnel for planning and management. Moreover, lack of growth in the student population and limited fiscal resources further increase the importance of prudent decision making. The use of interactive terminals, which can be connected to the computer anywhere there is a telephone, provides the necessary accessibility to the display and analytical tools described herein.

Public sentiment toward educational and administrative accountability makes it necessary that more attention be placed on the clear presentation of the reasons for reaching a particular decision. The tradeoffs among the many, often conflicting, educational goals must be explained. Both the visual display of data as well as demonstrations using computer models can be

invaluable in communicating the complexity of a given problem. Furthermore, interactive computing can also be used to allow the direct involvement of citizens in the planning process.

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